Update
FOREST HEALTH TECHNOLOGY
ENTERPRISE TEAM UPDATE
USDA FOREST SERVICE, STATE AND PRIVATE FORESTRY, FOREST HEALTH PROTECTION, FOREST HEALTH TECHNOLOGY ENTERPRISE TEAM SPRING/SUMMER 2002

AGDISP

"Crop dusting" with hi-tech

To spray or not to spray . . . The decision is a little easier now, thanks to this new technology

Software technology developed by FHTET and others is not only changing the way pesticides are being applied by aircraft, but changing long-standing public perceptions about them, as well. It's called AGDISP, and what it does is take much of the guesswork out of the thought process behind two essential questions: Do we spray or not? If we do/did spray, what will happen/happened?

This software was developed by the USDA-Forest Service, with the majority of technical work being done under contract by Continuum Dynamics, Inc. The Environmental Protection Agency, National Council for Air and Stream Improvement (NCASI), NASA and the US Army have all contributed to this development effort over the past thirty years.

According to **Harold Thistle** (FHTET-Morgantown), the R&D on AGDISP is on-going, and the driving thought behind it is this: If an applications manager could anticipate the conditions under which a pesticide is to be applied, then she/he would be able to:

1. Predict how much pesticide would land on and off target;
2. Calculate whether or not the pesticide concentrations landing on target would be effective against the target pest;
3. Assess the risks spraying would pose to human and environmental health.

Obviously, if the manager could do these three things, the decision to spray or not to spray would be easier to make.

What's in the Update. . .

AGDISP Facts:

AGDISP *helps predict where pesticides will land--page 1*

AGDISP *is cleaning up public perceptions about spraying--page 2*

AGDISP *calculates the effects of turbulence on aerial spraying--page 3*

AGDISP *and applications to biopesticides--page 4*

*Contact--**Harold Thistle** (FHTET-Morgantown) (304) 285-1574 hthistle@fs.fed.us*

What AGDISP does

AGDISP predicts or "models" what will happen to a pesticide after it is sprayed from an aircraft. Knowing what will happen enables the applications manager to formulate an optimal aerial spraying program.

In a perfect world, an absolute minimum amount of pesticide would be used, 100% of it would fall within the target area, it would be 100% effective against only the target pest, and it would have no residual or negative impact on either human or environmental health. Absent perfection, AGDISP allows the user to calculate how much pesticide will land and where. That is, the user

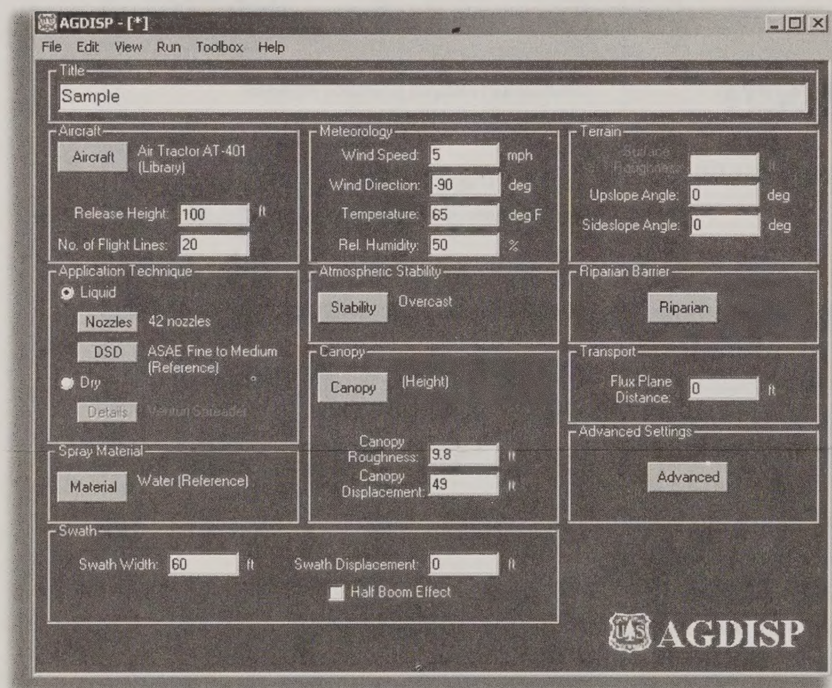
(Continued, page 2)
More about AGDISP, pages 2, 3, 4

AGDISP, *continued from page 1*

can define an optimal program that: (1) requires the least amount of pesticide; (2) produces a minimum amount of off-target drift; and (3) poses the lowest possible risk to human and environmental health.

After all this, the user might determine that the values calculated by AGDISP still appear to be too high—meaning unsafe and/or ineffective—in which case the decision would be made not to spray.

How AGDISP works



AGDISP is a Windows®-based, data-intensive software program. Some of the data is contained in searchable lookup tables and some must be entered by the applications manager. Searchable data include such things as aircraft types, nozzle drop size, distribution patterns, and forest canopy types. Data input by the applications manager include such things as weather and terrain (slope) conditions.

Once the applications manager has selected and input all data, AGDISP generates a set of charts depicting such things as the amount of spray that will evaporate *vs.* the amount that will land on the forest canopy and the ground, and how far from the target area any errant spray might drift. If the charts point to an unacceptable outcome, the applications manager can, *wherever practical*, modify the input until the outcome is acceptable, or optimized. "Practical" is the operative word, here.

(Continued, page 4)

A primer on aerial spraying

It all began in Louisiana in 1922. That was the year when the first plane went aloft with a cargo of sulfur powder and proceeded to broadcast it over croplands. Hence the name, "crop dusting." The practice was immediately popular as large areas could be treated quickly, boosting production and profit. In the early years, environmental concerns were not preeminent, but drift has always been a concern as it wastes material and can have deleterious effects on non-target crops.

Since the 1970s, increasingly tighter regulations and better spray application technologies have redefined which pesticides can be used, who can apply them from an aircraft, and how, when, and where they can apply them. Now called "aerial spraying," it is a cleaner, safer, and more cost-effective practice than previously. Yet for all that, the crop duster image lingers in the public perception.

AGDISP is helping to clean up that image by taking a lot of the guesswork out of aerial spraying.

During the pesticide registration process, the Environmental Protection Agency (EPA) now accepts AGDISP results in lieu of observed data to evaluate drift potential. The EPA can conduct a risk assessment based on the reports AGDISP produces—predictions for how much chemical will land both on and off target, etc.—and determine whether or not the chemical is acceptable.

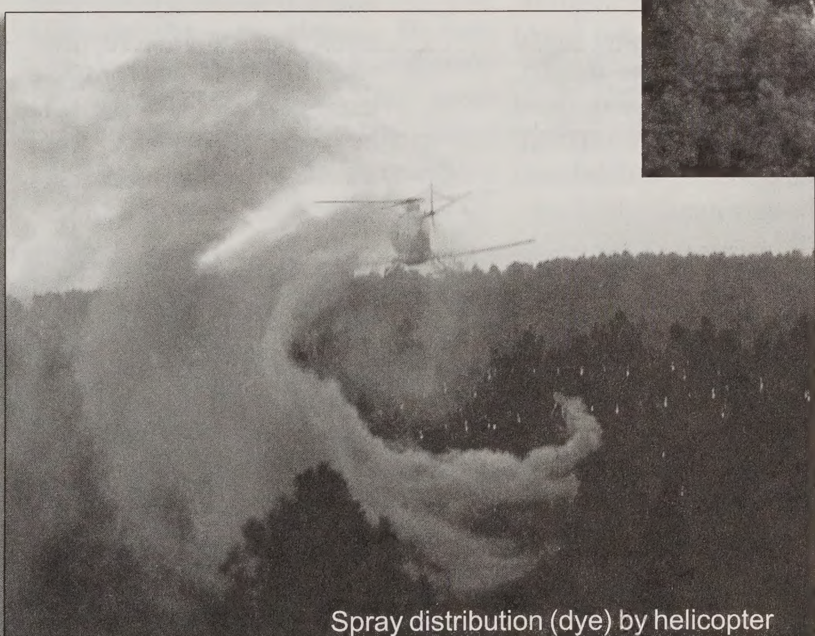
AGDISP also can be used "after the fact" to determine whether or not a specific aerial spraying operation might have been responsible for an alleged accident. Let's say a beekeeper files a complaint with local authorities alleging that chemicals from an aerial spraying operation drifted onto her/his property and killed all the bees. Using AGDISP, investigators could reconstruct the conditions under which the operation was carried out and determine the likelihood that the spraying program was responsible for the damage.

More about AGDISP, pages 1, 3, 4

AGDISP in the air: a turbulent a-*wake*-ning

AGDISP uses aircraft turbulence as a tool

Concerns regarding the precision of aerial spraying are understandable. Where the spray actually lands depends on many variables. In all, AGDISP considers about three dozen such variables, including, among others: The size of the droplets sprayed; how much evaporation takes place before the droplets land on the forest canopy; weather conditions, including wind direction and speed; and the extremely complex issue of wake turbulence created by the aircraft.


Spray distribution (dye) by helicopter

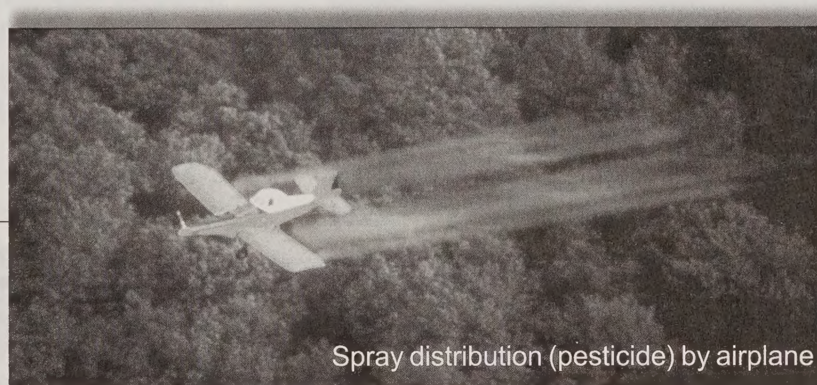
Terry McGovern, USDA APHIS PPQ, www.forestryimages.org, UGA2652038

Aircraft Wake

If you can imagine one or more small tornadoes tipped on their sides and trailing behind an aircraft, you'll have a general idea of what aircraft wake is, what it looks like, and how it behaves. Now, imagine what that wake does to the spray released from an aircraft. Much of the material that is sprayed is captured in the wake and the wake determines where that material will land. NASA and the USDA have spent substantial effort researching and modeling wakes and much of what has been learned has been incorporated into AGDISP's datasets.

The work shows that not all wakes are created equal: They vary markedly between aircraft types (helicopters vs. planes) and models. Aircraft weight; propeller speed; wing height, width, length, angle and position relative to the fuselage; size and shape of the fuselage and wingtips—essentially every surface outside the cockpit influences the size, shape, and strength of the wake.

Comprehensive data used to calculate wakes for over 120 of the most common helicopter and fixed-wing aircraft used in aerial spraying are incorporated into AGDISP's datasets. The applications manager selects a specific make and model of aircraft from a lookup table, and AGDISP loads the corresponding datasets and displays the pertinent data on the monitor. The manager can then modify the data wherever appropriate, which could include modifications known to have been made to the actual aircraft to be flown. Examples of modifications might be changes in gross weight of the aircraft, or its average flight speed.

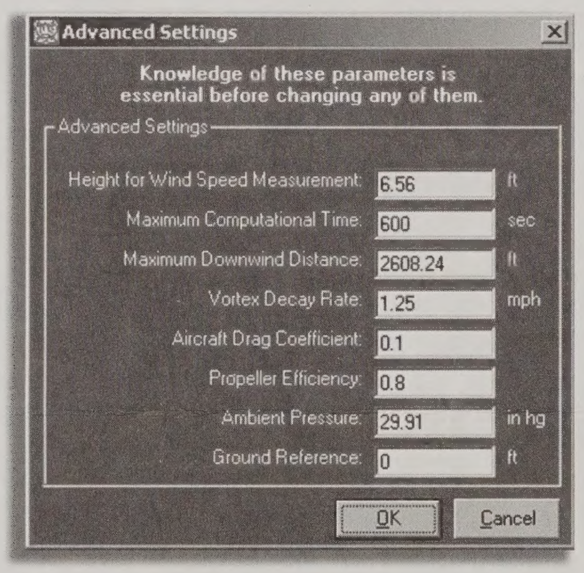

Spray distribution (pesticide) by airplane

Larry R. Barber, USDA Forest Service, www.forestryimages.org, UGA2652038

More about AGDISP, pages 1, 2, 4, 5

AGDISP, *continued from page 2*

It would make no sense for the applications manager to modify data over which he/she has no practical control. For example, there would be no point in modifying the terrain or the canopy type unless the original data were incorrect. Like-wise, changing aircraft types, nozzle configurations, or spray materials would make no sense if the new aircraft, nozzles or spray material were unavailable.



Two hypothetical examples illustrate how this works:

1. Assume AGDISP indicated that, under the conditions described by the applications manager, the spray would evaporate rapidly behind the aircraft and result in an ineffective application. To decrease the rate of evaporation, the manager might input a different nozzle configuration, one that would create a larger spray droplet, and/or input a slower air speed for the aircraft. AGDISP would then re-calculate based on the new input.

2. Assume AGDISP indicated that the conditions described by the applications manager would be unacceptable because they would result in a high level of off-target drift. To decrease the amount of drift, the manager might input a new nozzle configuration and/or a slower wind speed. Obviously, while the manager can control the nozzle configuration, he/she cannot control wind speed. But the manager can set the conditions under which the application will go forward. For example, if AGDISP indicated the combination of the new nozzle type plus a lower wind speed (5mph *vs.* 10mph) would result in less off-target drift, the manager could qualify the flight by saying, "Spray larger drops and stay away from block edges when the wind exceeds 5mph."

AGDISP in application: how it is being used

As is the case with all FHTET applications, user need and technology have driven AGDISP's development. As computers became more powerful and portable, so did AGDISP. Likewise, as demands and techniques change in the spraying industry, so will AGDISP.

AGDISP is being developed by the US Government and is in the public domain, meaning the software is available to anyone who wants to study or use it. Its development included incorporation into AGDRIFT, a proprietary industrial model. AGDRIFT uses AGDISP as its computational engine. The EPA now uses AGDISP and AGDRIFT to conduct risk assessments on pesticide exposure. Whether undertaken by the Government or private industry, risk assessments go a long way toward balancing the need for pesticides against both commercial interests and the mounting public demand for better pesticide applications and the safer pesticides.

The quest for safer pesticides has led to the commercial development of biological pesticides. These are naturally occurring agents such as bacteria, viruses and fungi that control pests. Because they're natural, biopesticides are considered safer to the environment than conventional chemical pesticides. Even with the development and use of these environmentally safer pesticides, AGDISP remains a critical tool for pest managers. AGDISP has long been used, both as a stand alone tool and as part of other Forest Service models, to analyze spray applications of *Bacillus thuringiensis* (*BT*) to combat gypsy moth. *BT* has very low mammalian toxicity—it is allowed in organic farming—but efficacious and economical spray programs still require a detailed understanding of the factors incorporated into AGDISP.

More about AGDISP, pages 1 - 3

Steering Committee Report

Strategic Direction Reviewed

The FHTET Steering Committee held its annual meeting May 14-15 in Chicago hosted this year by the Northeastern Area Assistant Director **Ken Knauer**. The meeting focused on the Team's *1998 Strategic Plan*, now five years old. Although much of the plan's direction is still relevant, it does not reference or tier to the *Forest Service Strategic Plan* (October 2000) nor the upcoming *FHP Strategic Plan*.

FHTET Directors **Allan Bullard** and **Andy Mason** agreed with the Committee that the Plan should be revised slightly, and will work with Committee members **Dennis LeMaster** and **Greg Fitch** to develop a draft plan by September 2002. Areas of particular consideration in the revised plan are: invasive species, including plants; technology transfer; data modeling and data/map overlays to assist with NEPA planning requirements; national standards for survey and reporting; ensuring pesticide application technology expertise; web applications; and adding "chemical pesticides" as a work area.

FHP staff from the Northeastern Area (**Noel Schneeberger** and **Dennis Haugen**) coordinated an outstanding field trip to Asian longhorned beetle (ALB) survey and treatment areas in Chicago. The trip included a driving and walking tour in the heart of the infested area, the Ravenswood community. The Committee learned about the history of the project, the extensive public involvement and outreach efforts, the detection survey work. Presentations were given by many cooperators including Animal and Plant Health Inspection Service (APHIS), State of Illinois, City of Chicago, and the Forest Service.

Demonstrations of new technology were part of the trip, as well. **Therese Poland** (Forest Service North Central Research Station) demonstrated the use of an acoustic detection "listening" device, funded in large part by FHP's Special Technology Development Program (STDP), that can detect ALB infestations in live trees (see photo, left).

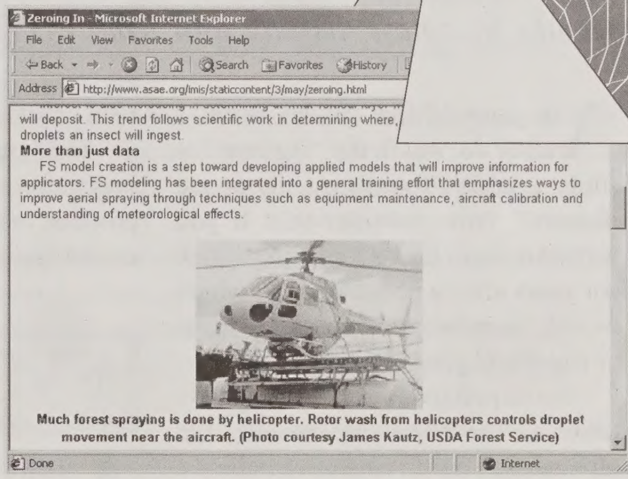
All participants agreed that the Chicago ALB project is an excellent example—and in fact a real success story—of how agencies can work together, with public understanding and support, to control and eradicate an invasive pest.

The Committee was also briefed by FHTET Program Manager for Information Systems **Loren Iverson** on several FHTET-sponsored/

Continued, page 7

The Web Corner

http://www.asae.org/imis/staticcontent/3/may/zeroing.html



On this site, you'll find an interesting and concise introduction, *Zeroing in on Forest En-emies: Computer modeling improves aerial spraying accuracy*, co-authored by **Harold W. Thistle** (FHTET-Morgantown), **Milton E. Teske** (Continuum Dynamic, Inc., Ewing, NJ) and **Daniel B. Twardus** (FHP-Morgan-town).

For links to other sites, "Google it" by going to

http://www.google.com

and entering AGDISP or AgDRIFT as your search.

FHTET has a new technology transfer tool called the *Fact Sheet*. These "one-pagers" provide brief status reports about some of the Team's ongoing technology development projects and products.

http://www.fs.fed.us/foresthealth/technology/fact_sheets.shtml

FVS-EMAP:

Viewing gigabytes of What-if? *data just got easier, thanks to a new display tool from* FHTET

Ask yourself this: Which would I rather do, watch the "big race" or study a table of statistics about the runners? Now consider this: If you wanted to know how a forest might look ten years after a pest outbreak, which would you rather review, colored maps or pages and pages of data tables?

As important as statistics and data tables are, the answers are obvious. The obvious was the driving force behind a new software utility program developed by FHTET. It's called the Forest Vegetation Simulator-Event Monitor ArcView® Project utility, or FVS-EMAP, and what it does is enable modelers, resource managers, geographers, and GIS professionals to produce maps in the ESRI ArcView® geographic information system from tabular data (tables) produced in the Forest Vegetation Simulator (FVS) modeling software.

Essentially, FVS-EMAP functions as a translator between FVS and ArcView®. FVS produces tabular data of projected or simulated changes in landscape vegetation, and ArcView® uses data to produce maps. However, ArcView® cannot understand the *tabular* data FVS

Continued, page 7

FVS-EMAP Facts:

FVS-EMAP is used to model fire and fuel loads for next 20 years--page 6

Insect hazard rating EM addfiles can be used as input in FVS-EMAP--page 7

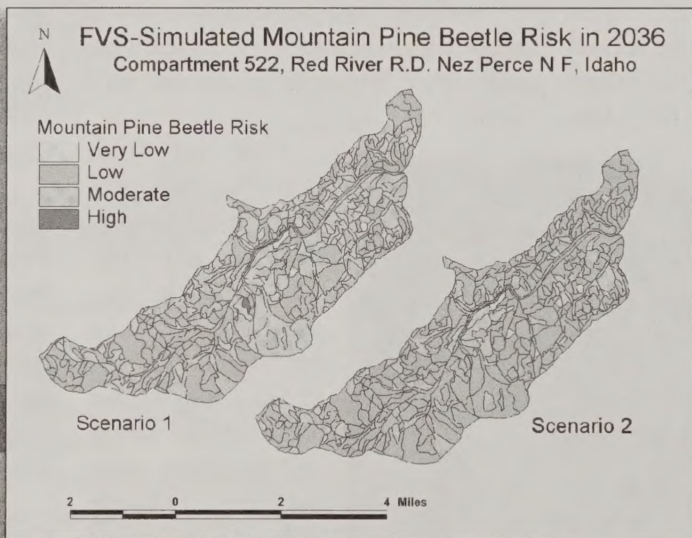
*Contact--**Eric L. Smith** (FHTET-Fort Collins) (970) 295-5841*
elsmith@fs.fed.us

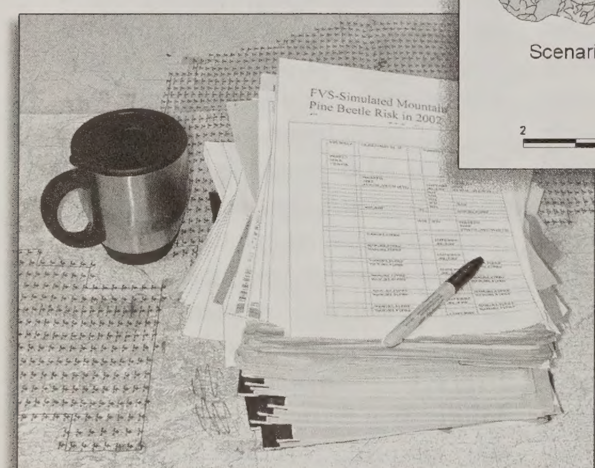
FVS-EMAP: A case study

A major outbreak of the mountain pine beetle (*Dendroctonus ponderosae*) in lodgepole pine is underway in the Nez Perce National Forest. As part of the response to this outbreak, data collected from an 80,000-acre watershed has been used to test the Forest Vegetation Simulator's (FVS) Western Pine Bark Beetle Model. The staff of Regional Forest Health Protection has digitized aerial survey maps back to 1984, and summarized mountain pine beetle information for the entire outbreak area.

The FVS is being used to model stand information to 1996, a common year for the start of the beetle outbreak. The stands are being "grown" from that year forward to today. FHP information on the outbreak will be melded with the model outputs, and the FVS fire and fuel model will then be used to predict periodic fuel loads over the next 20 years.

FVS-EMAP will be used to generate maps of the model outputs. Together with the tabular data from the FVS Event Monitor, the maps will be used to evaluate potential changes/simulations in disturbance regimes and vegetation composition and structure, and to delineate areas in close proximity to homes and administrative facilities that show a potential either for unnaturally severe fire effects or behavior.





FVS-EMAP readily converts piles of tabular data into visually appealing, easy-to-understand maps.

FVS-EMAP, continued from page 6

produces. Hence, it can't use it. Enter FVS-EMAP. FVS-EMAP translates the tabular data into a "language" ArcView® understands and can use to produce maps.

This function is of particular value to FVS users because it enables them to map current or future stand conditions—stand basal area, stand age, trees per acre, etc.—for multiple stands and simulation scenarios. Prior to the development of FVS-EMAP, there was no convenient way to do this.

Steering Committee Report, continued from page 5

developed products and Web sites, including: Forestry Images (http://www.forestryimages.org/); Exotic Forest Pests Information System of North America (http://www.exoticforestpests.org/); Vegetation Management Tools (http://www.fs.fed.us/foresthealth/vegtools); and Invasive Species Issue Team (http://www.fs.fed.us/foresthealth/invasives). The Committee also was updated on three major Web database applications under development: Aerial Survey Maps; Special Technology Development Program Project Database; and the Internet Decision Protocol.

The FHTET Steering Committee was organized in 1996 to provide strategic guidance to the Team in program selection and direction, to provide leads on potential enterprise opportunities, and to help promote awareness of the Team's products and services. For a list of committee members, go to http://fsweb.ftcol.wo.fs.fed.us/fhtet/steering/Steering_Com_Members_April02.doc.

Tech Points

EM Addfiles:

FHTET has produced Event Monitor (EM) addfiles that calculate insect hazard ratings. Output from these addfiles may be used as input into FVS-EMAP.

1. *Mountain Pine Beetle in Lodgepole Pine Hazard Rating System (I).* Based on *Amman et al. 1997.*
2. *Mountain Pine Beetle in Lodgepole Pine Hazard Rating System (II).* Based on *Randall and Tensmeyer 2000.*
3. *Spruce Beetle Hazard Rating System* Based on *Schmid and Fry. 1976.*

Also, FHTET has produced a Stand Summary Statistics Addfile that reports basic FVS output variables.

The above addfiles and associated documentation are available at http://www.fs.fed.us/foresthealth/technology/fvsemap/index.html

What FVS-EMAP can map:

1. *Pre-defined EM variables.* Many variables representing a wide variety of site, tree, and stand attributes are available within the EM. FVS users can access all pre-defined EM variables and can write them to output files. FHTET has produced an EM program that outputs basic stand summary information; common stand variables are available for mapping.
2. *User-defined variables.* Users can create new variables with mathematical manipulations of either user- or pre-defined EM variables. Stand conditions such as wildlife habitat indices and pest hazard ratings can be calculated with this approach.
3. FVS-EMAP can be used to make growth-and-yield estimates, and to map computed conditions, such as hazard ratings, for a project area.

What you need to use FVS-EMAP:

1. Standard FVS software and input data.
2. Appropriate FVS keyword file containing the COMPUTE keyword and expression(s) defining variable(s) of interest.
3. The "Compute2" post-processor (available with FVS software).
4. An ArcView® shapefile representing the simulated stands, providing the information needed to map stand boundaries.
5. ArcView® GIS software, ver. 3.2 or higher (available on USDA Forest Service IBM® computers).
6. The custom ArcView® project, EMAP.apr (available at http://www.fs.fed.us/foresthealth/technology/fvsemap/index.html).

NOTE: Input to FVS-EMAP is generated by the FVS Event Monitor (EM) using COMPUTE keywords. All variables are calculated via the COMPUTE keyword and be mapped using this process.

FVS

The Forest Vegetation Simulator (FVS) is an individual tree, distance-independent growth and yield model with linkable modules (extensions) that simulate the impacts of insects, pathogens, and fire, fuel loading, snag dynamics, and understory vegetation development. FVS can simulate a wide variety of forest types, stand structures, and pure or mixed-species stands.

USDA Forest Service

Forest Health Technology Enterprise Team
2150 Centre Avenue
Building A, Suite 331
Fort Collins, CO 80526-1891

http://www.fs.fed.us/foresthealth/technology/

PRSRT STD
US POSTAGE
PAID
USDA FOREST SERVICE
PERMIT NO G-40

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

*********************AUTO**MIXED AADC 800
USDA, ARS, NAT'L AGR LIBRARY 2
CURRENT SERIAL RECORDS, RM 002
10301 BALTIMORE AVE
BELTSVILLE MD 20705-2326

1283

EVENTS

Second International Seminar on Forestry Information Technology, September 3-4, Helsinki, Finland. Contact: Esko Mikkonen, esko.mikkonen@helsinki.fi; http://www.forestit.net.

IUFRO S 4.11 Symposium on Statistics and Information Technology in Forestry. September 8-12, Blacksburg, VA. Contact: http://www.conted.vt.edu/iufro.htm.

50th Annual Meeting of the Western International Forest Disease Work Conference, September 9-13, Powell River, British Columbia, Canada. Contact: (604) 485-3000; http://www.fs.fed.us/foresthealth/technology/wif/index.html.

Advanced ArcView GIS Applications in Natural Resources, September 26-27, Corvallis, OR. Contact: Conference coordinator, (541) 737-2329; outreach@for.orst.edu; http://www.cof.orst.edu/cof/extended/conferen/. *CFE/ACF credit: 14 hours, Category 1.*

Upland Oak Ecology; History, Current Conditions, and Sustainability, October 8-10, Fayetteville, AR.. Contact: Carroll Guffey, (870) 460-1549; guffey@uamont.edu; http://oaksymposium.uaex.edu.

Managing for Forest Health, October 21-23, Gainesville, FL. Contact: School of Forest Resources and Conservation, (352) 846-0849; sfrc@gnv.ifas.ufl.edu; http://continuinged.sfrc.ufl.edu.

Annual Gypsy Moth Review, Nov 4-7, 2002, in association with the *Spray Efficacy Research Group [SERG] Workshop,* Nov 7-9, Niagara Falls, Canada. Contact: Patricia Cuglietta (613) 225-2342, cugliettap@inspection.gc.ca.